

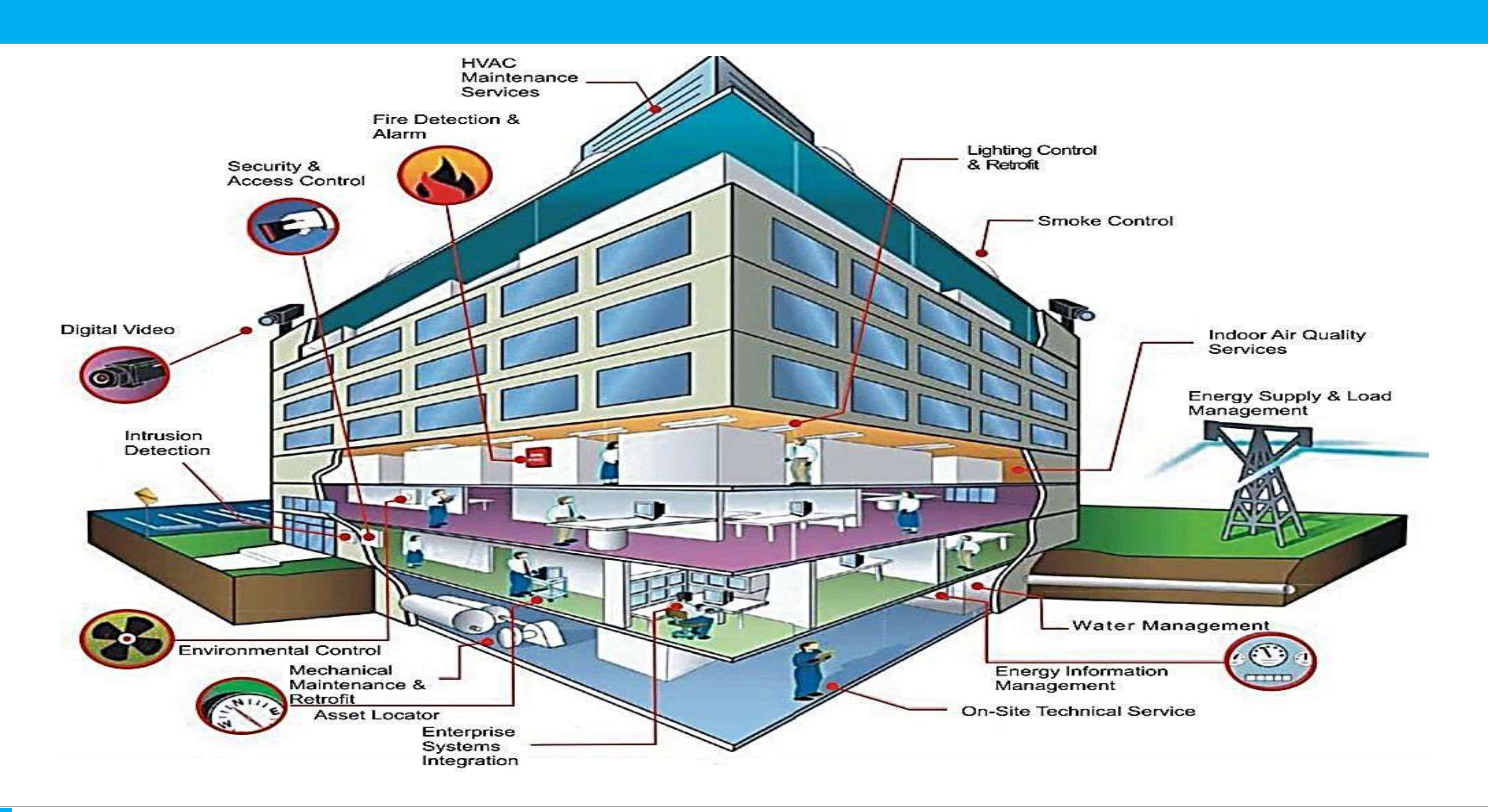


BUILDING MANAGEMENT SYSTEM BASICS

Eng. Tarek Aboukhadra

Contents

1. INTRODUCTION


HVAC Maintenance Services
Fire Detection & Alarm
Security & Access Control
Lighting Control & Retrofit
Smoke Control
Digital Video
Indoor Air Quality Services
Energy Supply & Load Management
Intrusion Detection
Water Management
Environmental Control
Mechanical Maintenance & Retrofit
Energy Information Management
Asset Locator
On-Site Technical Service
Enterprise Systems Integration

The major Building Control Systems vendors?













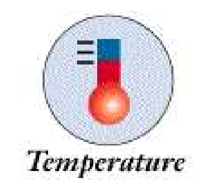
2- Building Management System (BMS) Definition

Building management system, BMS: is an umbrella term It is used to refer to a wide range of computerized building control systems, from special- purpose controllers, to standalone remote stations, to larger systems including central computer stations and printers.













A BMS comprises several subsystems which are connected in various ways to form a complete system.

The system has to be designed and engineered around the building itself to serve the services systems include HVAC systems, electrical systems, lighting systems, fire systems and security systems and lift systems.

- Building Management Systems (BMS) also known as Building Automation Systems (BAS), Building Management and Control System (BMCS), Direct Digital Controls (DDC) and Building Controls (BC)
- BMS – Building Management Systems
- BAS – Building Automation Systems
- BEMS – Building Energy Management Systems
- EMS – Energy Management Systems
- EMCS – Energy Management Control Systems
- EPMS – Energy Power Management Systems

These various terms all had separate origins, and today you may find small nuances between software vendors still using each of these terms.

There is no differentiation between BMS and BAS. The two terms are frequently used interchangeably in the industry. For some time, vendors were trying to differentiate Building Automation Systems as an advanced version of Building Management Systems. But then everybody started to call their BMS a BAS.



Controlling Operations

- AHU
- Chillers
- FCU
- Boilers
- Pumps
- VFDs

Server

Workstation

Client

InstrumentationTools.com

Printer

Drive

Operator Control Room

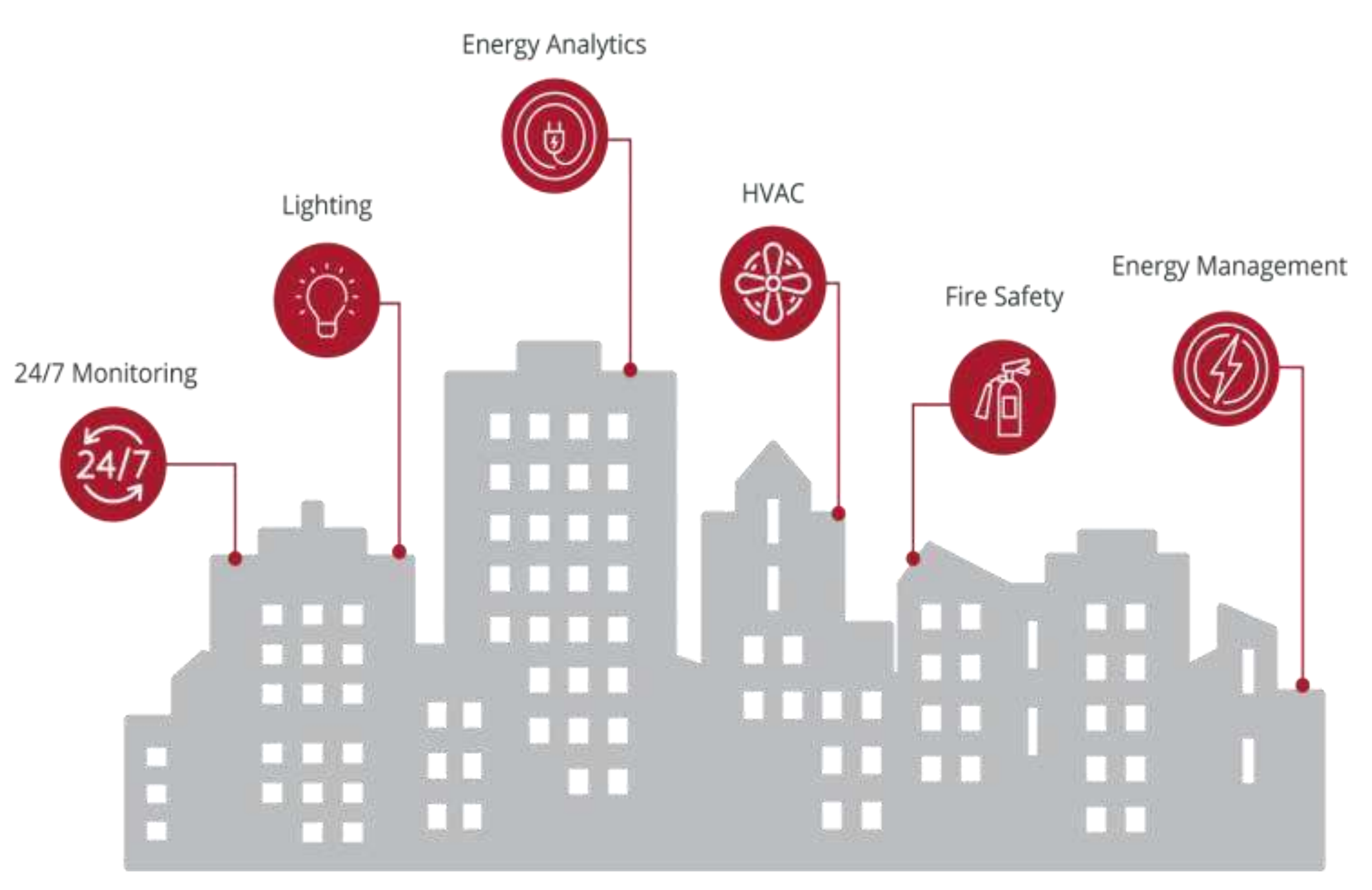
Management Operations

- FAS
- EMS
- Elevators
- Energy Meters
- Water Meters
- CCTV

3- What is the role and benefits of a BMS?

Building Management System is a system of monitoring, operation, and control of all activities of the building(s) or facility in a central way.

BMS' role is to facilitate the operation and evaluation of a building ,it helps in the control of various building design parameters, as well as by recording building operating data and commissioning other important information. When integrated with various building systems such as heating, ventilating and air conditioning (HVAC) equipment, security access control systems and lighting, the optimum in energy-efficiency and building management is derived.



- ## The Day to Day Role of the BMS

The most common primary function of the BMS is the control of HVAC Systems including :

Air Handling Units

Chilled Water Plant

Heating Water Plant

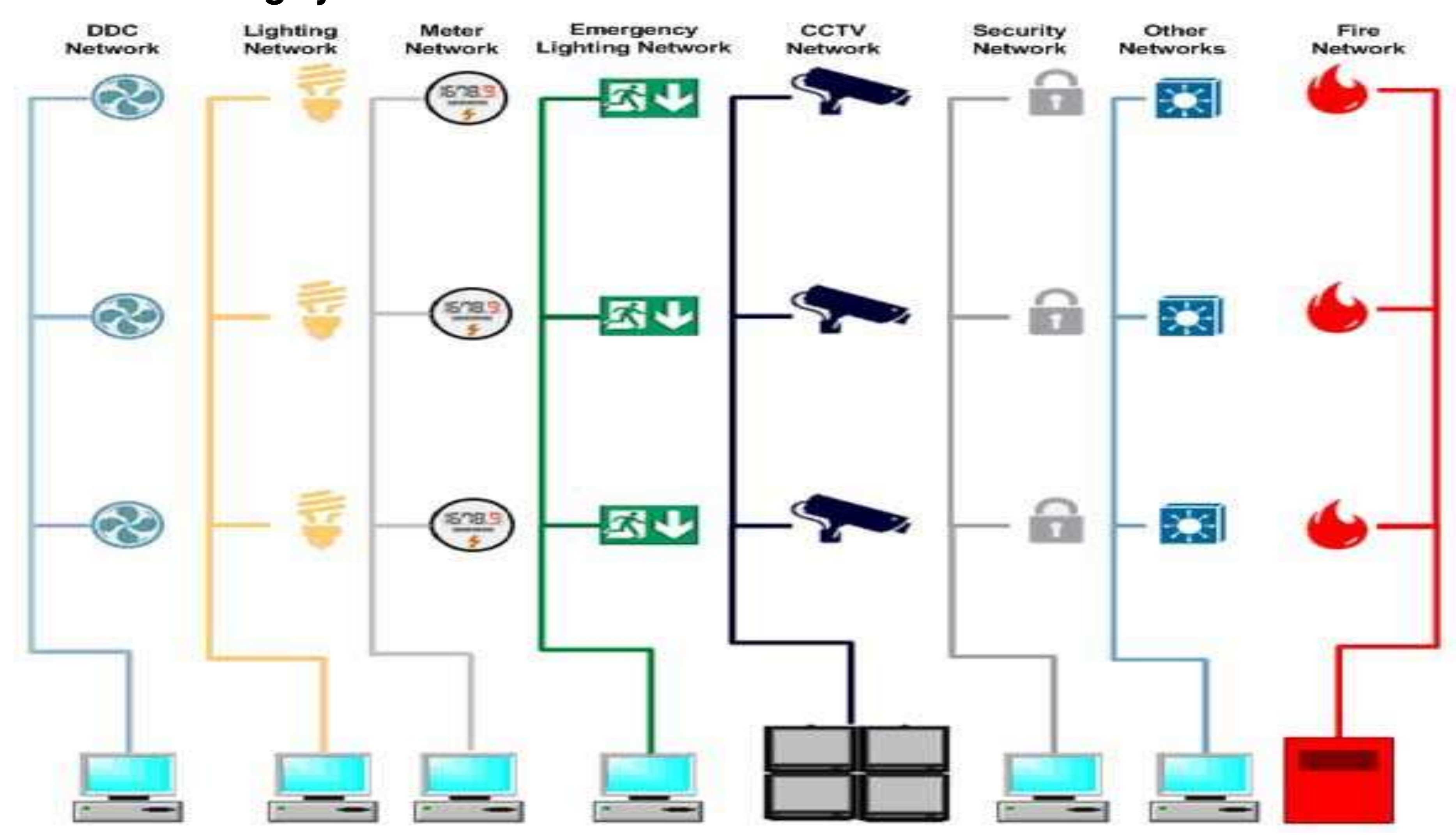
Exhaust Systems

- Control of Building Systems and Services
- Graphic User Interface (GUI)
- Real Time Monitoring of Building Operation and Performance
- Trending and Logging of Building Operation and Performance
- Time Scheduling of Building Systems
- Fault Management and Alarming
- Control Application Programming
- User Event Management

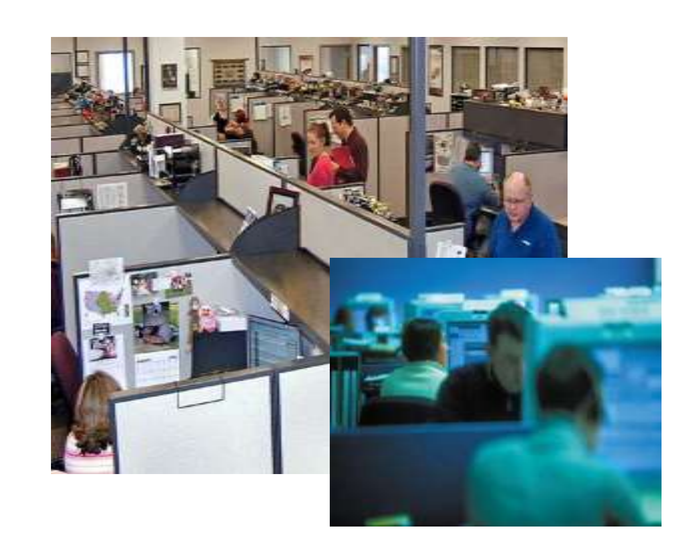
- **Building control applications include for following:**
  - Zone temperature monitoring and control
  - Zone Variable Air Volume (VAV) control to zones
  - Zone CO_2 monitoring and control (Air Quality)
  - Air handling unit supply air temperature control
  - Air handling unit supply air flow / pressure control
  - Main Plant Chiller and Boiler sequencing
  - Toilet, car park, kitchen and general exhaust fan control

- **Measuring and Monitoring Building Performance**
  - Operator Interfaces including Graphical User Interface (GUI) for monitoring and adjustments
  - Trend data is important when determining the stability of control algorithms and when tuning the system.
  - Equipment alarm and fault notification, reduces down time and consequential

Interaction With Other Building Systems



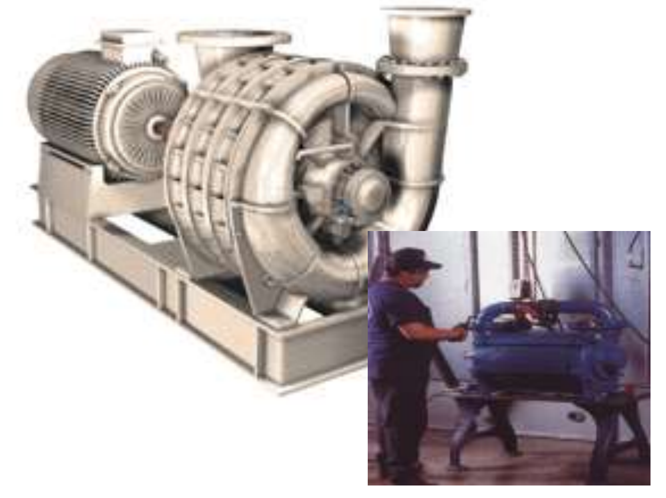
benefits of BMS



- **Improved indoor environment quality**
  - Comfortable living and working environment – domestic or commercial
  - Better temperature and humidity control
  - Good air quality

- **Faster response to ..**
  - occupant needs
  - end-user complaints
  - trouble conditions

- **Maintenance Savings.**
  - efficient control gives less wear and strain of mechanical equipment.
  - provides longer life
  - runtime monitoring alerts timely maintenance of equipment
  - avoids expensive failures



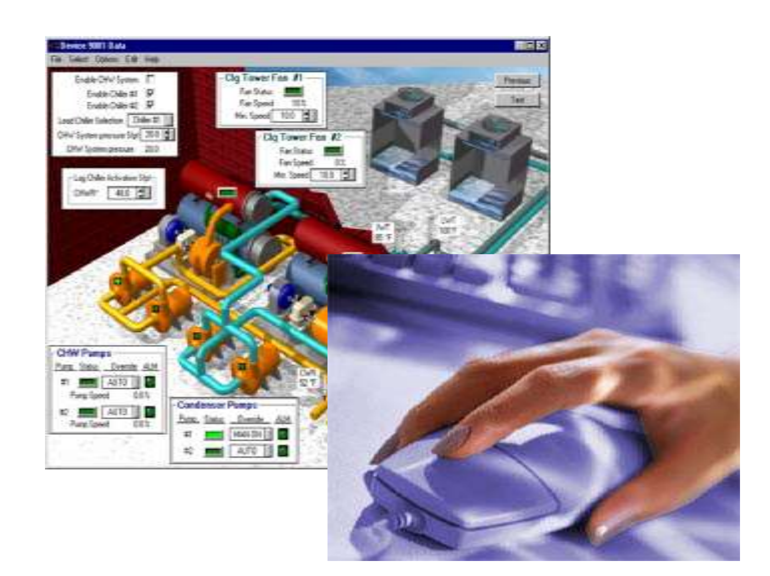
- **Energy Savings**
  - eliminates unnecessary system operation.
  - accurate energy usage information
  - helps you to take steps to reduce energy consumption like
    - Optimum-Start
    - Night-Purging
    - Time-Scheduling





Consolidated facility control…

- One point centralized operation
- Simpler operation
- Reduces time and resources





- on-screen instructions
- user-friendly graphic displays
- simpler operation programmed for routine and repetitive operation

- **Improved management reporting**
  - Provides valuable real-time data
  - Creates reports, charts…
  - Critical information immediately sent to printers, emailed
  - or sent via SMS
- **Timely and effective control**
  - alerts your employees when your facility is not operating correctly
  - reduce troubleshooting and down time.
  - Remote access connectivity without site visits.
- **Performance Benchmarking**
  - Facilitates the overall system performance measurement
  - Comparison with set benchmarks





Remote Access

4- Equipment **controlled** by BMS in buildings

These systems and services include:

1. Control of **HVAC** System.

2. **Lighting** Control.

3. **Elevators**, Escalators and conveyor belts.

4. Control of pumps and motors.

5. The system of billing the **water** consumed (hot or cold)

6. Billing system for the **electricity** consumed

7. **Fire alarm** and fire extinguishing control systems.

8. **Monitoring** and controlling fuel and water tanks.

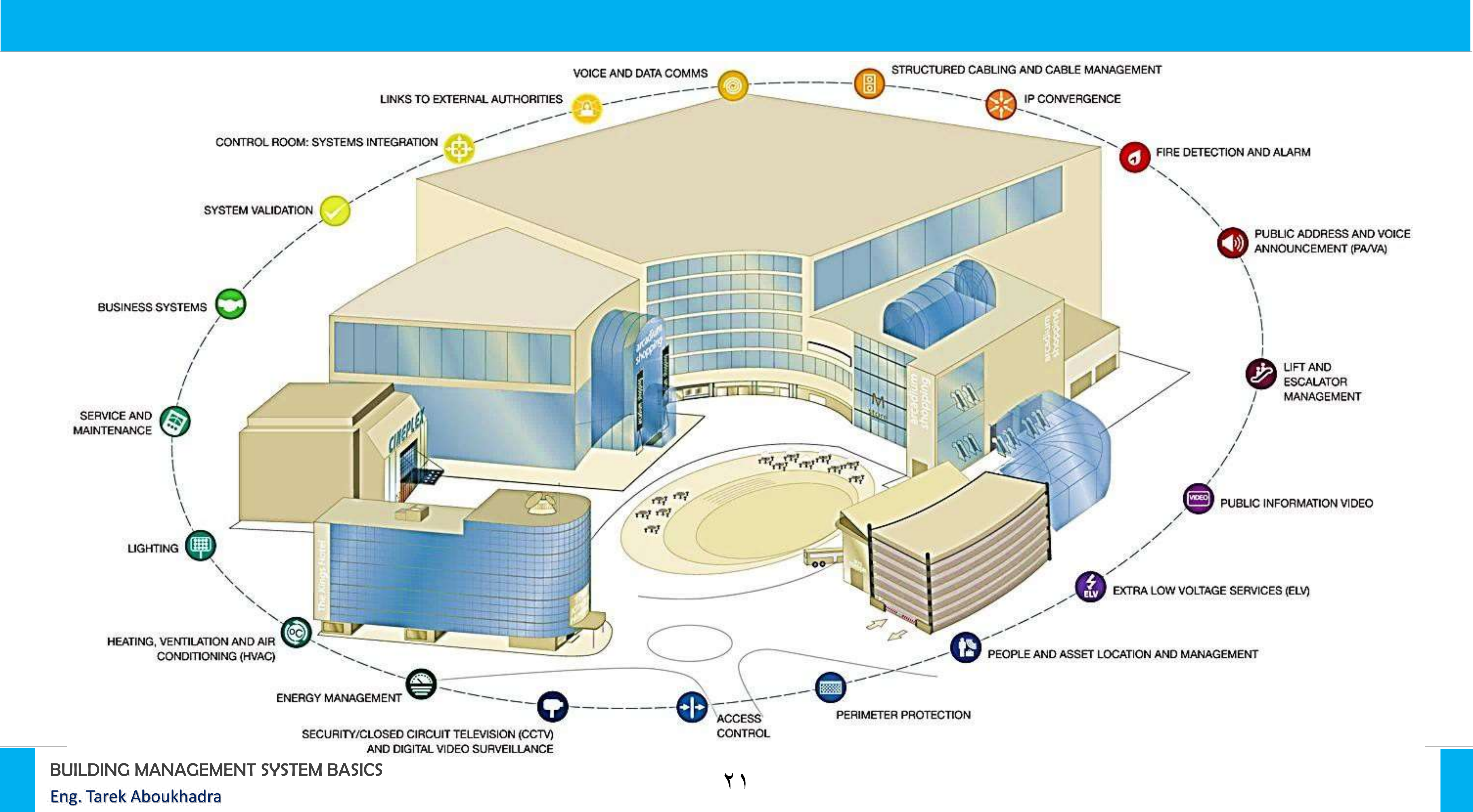
9. **Security** and anti-theft systems.

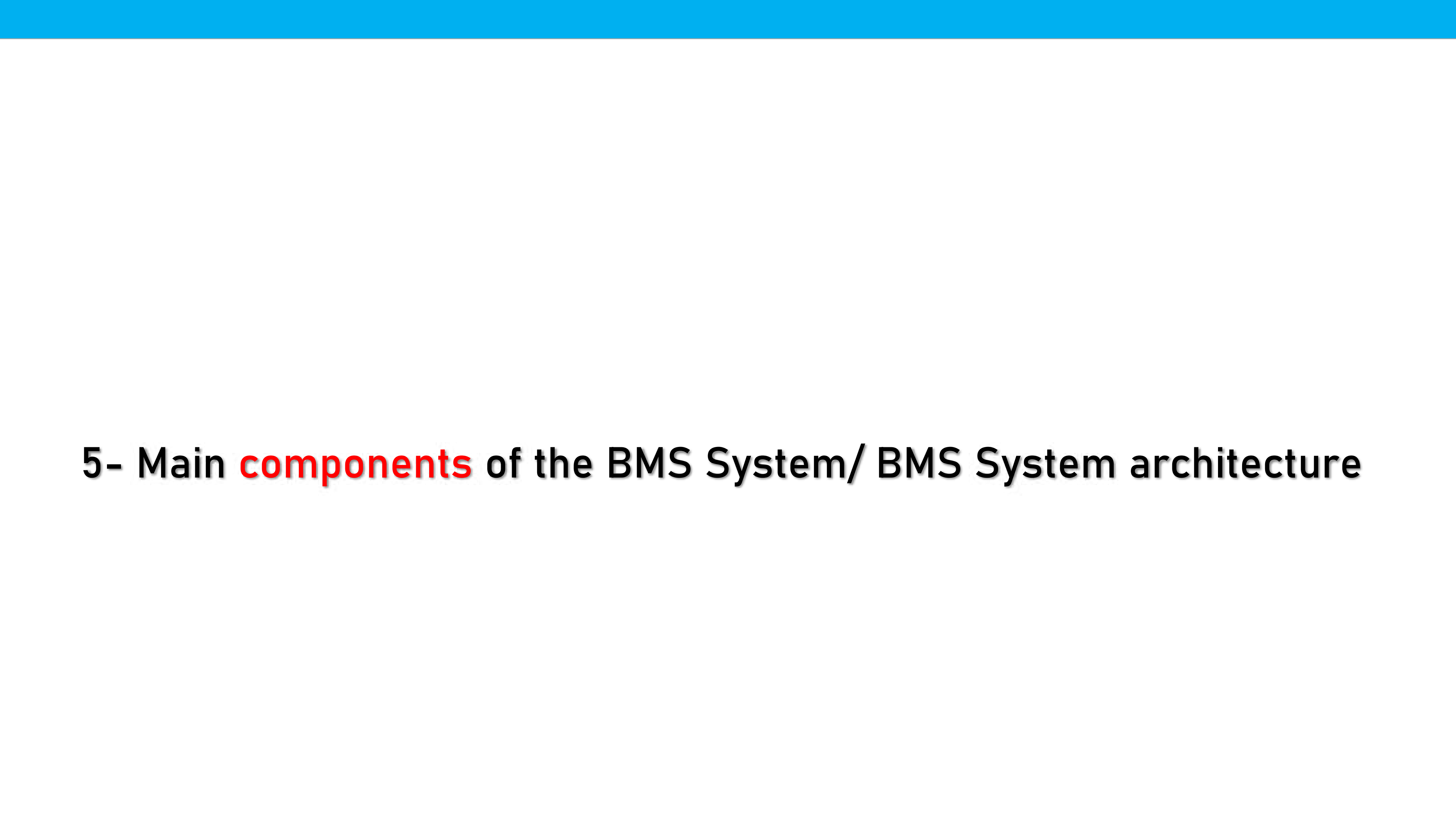
10. **CCTV** cameras.

11. **Access** control System

12. Monitoring and control of **generators**

ETC.

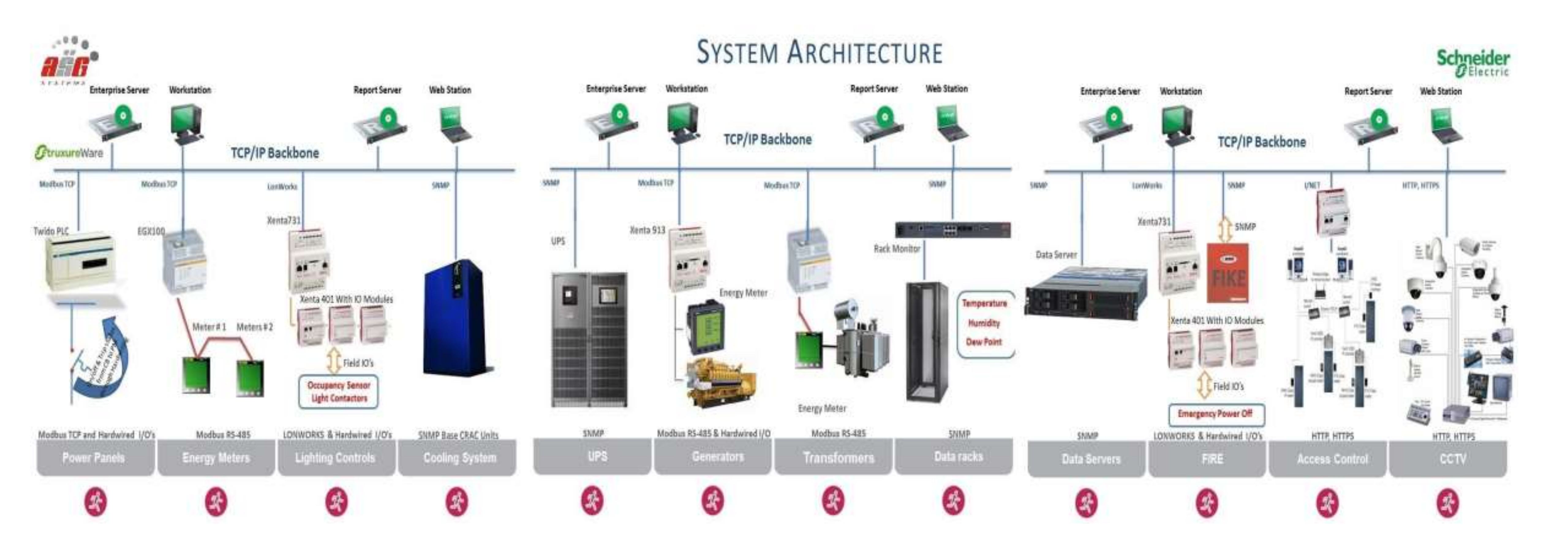

VOICE AND DATA COMMS
STRUCTURED CABLING AND CABLE MANAGEMENT
LINKS TO EXTERNAL AUTHORITIES
IP CONVERGENCE
CONTROL ROOM: SYSTEMS INTEGRATION
FIRE DETECTION AND ALARM
SYSTEM VALIDATION
PUBLIC ADDRESS AND VOICE ANNOUNCEMENT (PA/VA)
BUSINESS SYSTEMS
LIFT AND ESCALATOR MANAGEMENT
SERVICE AND MAINTENANCE
CINEPLEX
PUBLIC INFORMATION VIDEO
LIGHTING
EXTRA LOW VOLTAGE SERVICES (ELV)
HEATING, VENTILATION AND AIR CONDITIONING (HVAC)
PEOPLE AND ASSET LOCATION AND MANAGEMENT
ENERGY MANAGEMENT
PERIMETER PROTECTION
ACCESS CONTROL
SECURITY/CLOSED CIRCUIT TELEVISION (CCTV) AND DIGITAL VIDEO SURVEILLANCE

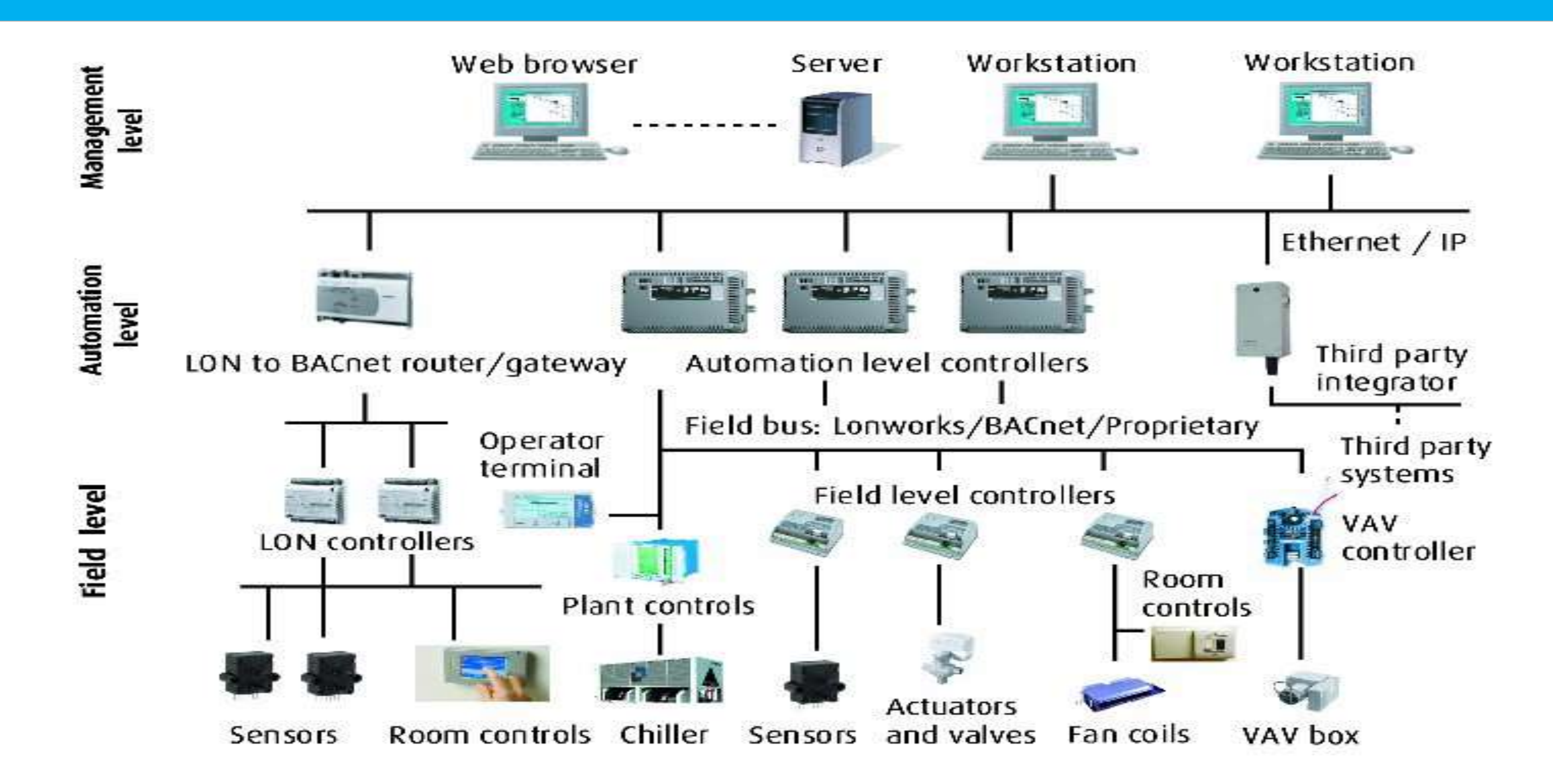


5- Main components of the BMS System/ BMS System architecture

System Architecture

BMS links functionality of building equipment TO operate as one complete integrated system.




Management level
Automation level
Field level
Web browser
Server
Workstation
Workstation
Ethernet / IP
LON to BACnet router/gateway
Automation level controllers
Third party integrator
Field bus: Lonworks/BACnet/Proprietary
Operator terminal
Third party systems
LON controllers
Field level controllers
VAV controller
Plant controls
Room controls
Sensors
Room controls
Chiller
Sensors
Actuators and valves
Fan coils
VAV box

Components of BMS

As per the level of monitoring and control, there are **three levels** in Building Management System.





1- Management Level (Centralized WorkStation Computer)

- With powerful user-friendly software.
- Used for everyday building operation.





2- Automation Level (DDC Controllers)

- Micro-processor based
- Pre-configured / Freely programmable
- Controls the HVAC equipment of the building





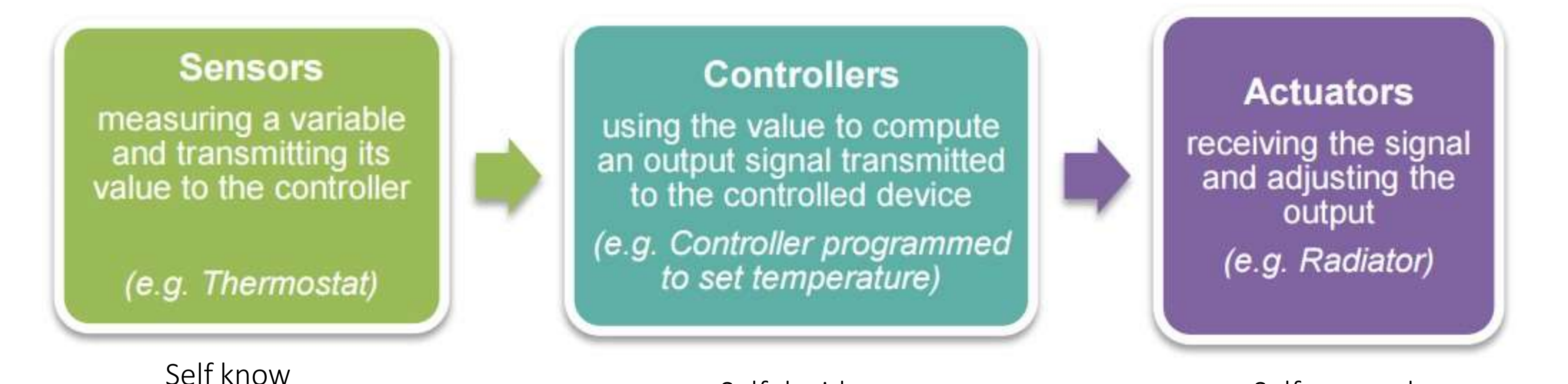


3- Field devices Level

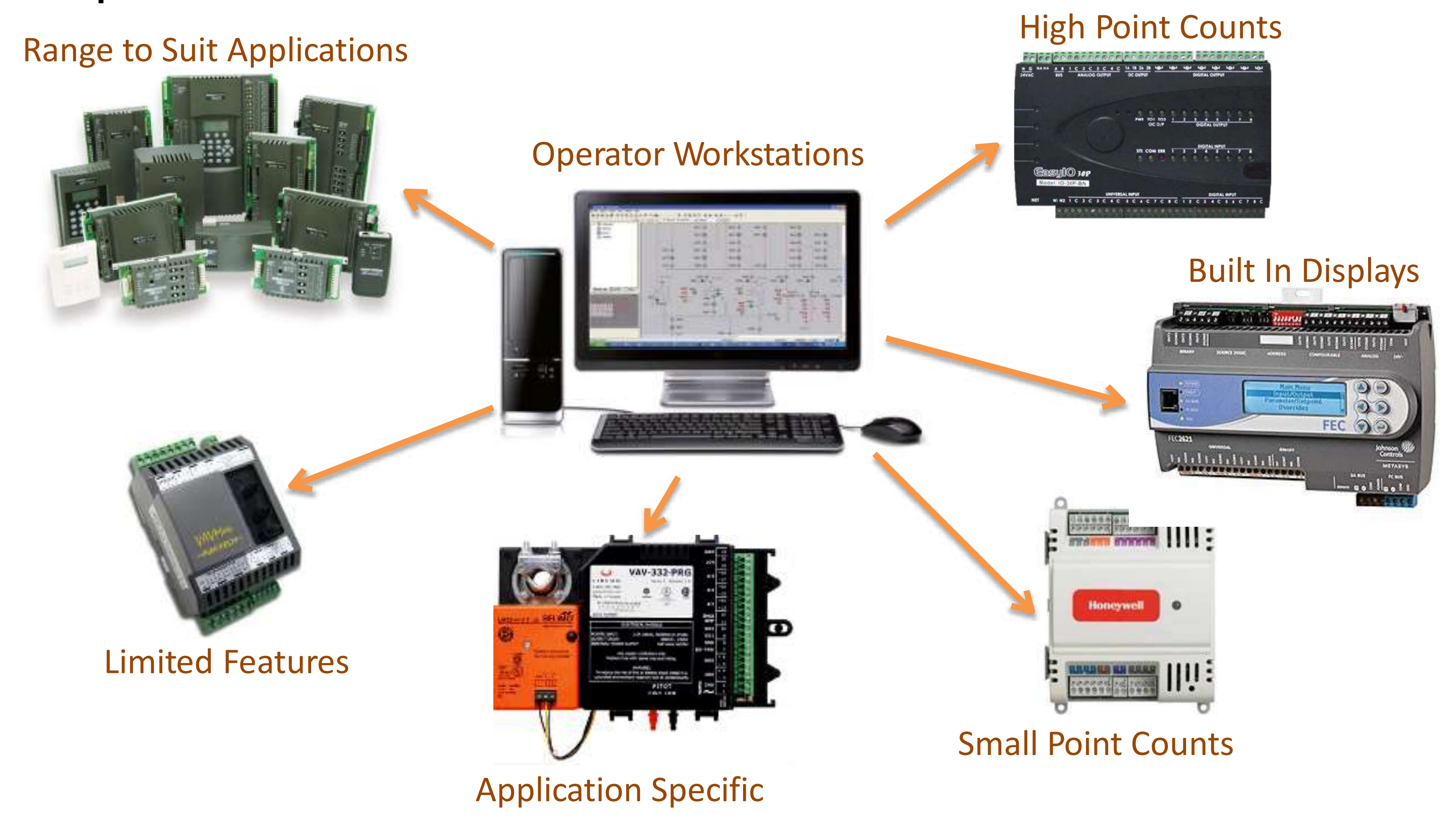
- Temperature, Humidity, Pressure sensors
- Valves, Actuators

Concept

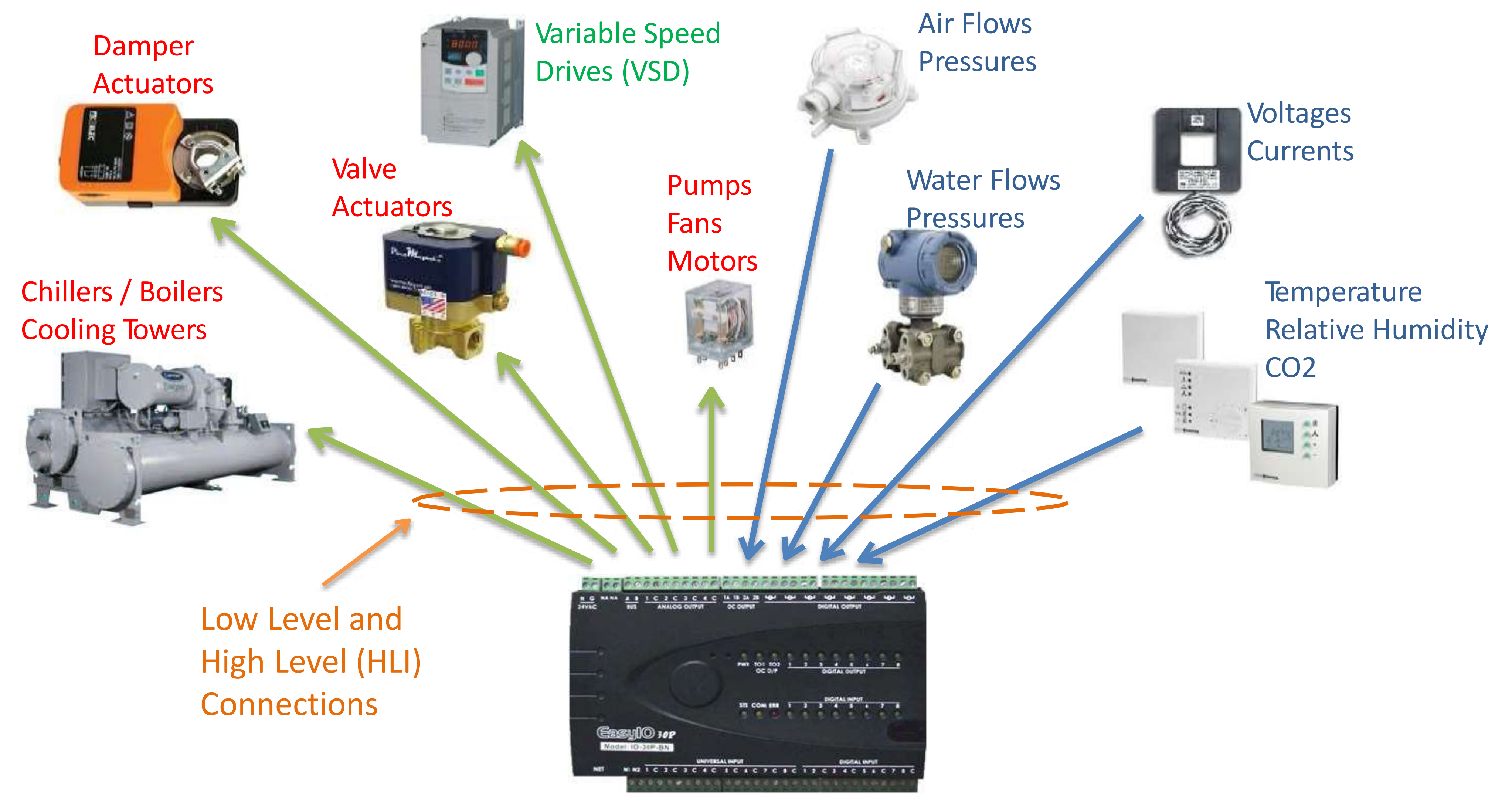
"self know, self decide and self respond"



Typical System Components – BMS Hardware



Typical System Components – Field Devices



- DDC - Direct Digital Control of an HVAC system

- A method of monitoring and controlling HVAC system performance by collecting, processing, and sending information using sensors, actuators, and microprocessors.

- DDC is the concept or theory of HVAC system control that uses digital controls

- Physically, DDC encompasses all the devices used to implement this control method: a whole group of DDC controllers/microprocessors, actuators, sensors, and other devices.



6- HVAC Equipment

HVAC systems are more used in different types of buildings such as industrial, commercial, residential and institutional buildings. The main mission of HVAC system is to satisfy the thermal comfort of occupants by adjusting and changing the outdoor air conditions to the desired conditions of occupied buildings

HVAC system selection

System selection depends on three main factors including the building configuration, the climate conditions, and the owner desire.
Some criteria can be considered such as climate change (e.g., temperature, humidity, and space pressure), building capacity, spatial requirements, cost such as capital cost, operating cost, and maintenance cost, life cycle analysis, and reliability and flexibility.

Basic components of an HVAC system

The basic components or equipment of an HVAC system that delivers conditioned air to satisfy thermal comfort of space and occupants and the achieve the indoor air quality are listed below:

. Air filter

. Supply fan

. Exhaust or relief fans

. Outdoor air intake

. Ducts

. Terminal devices

. Water chiller

. Humidification and dehumidification equipment

. Return air system

. Heating and cooling coils

. Cooling tower

. Boiler

. Control



Air Cooled Chiller



Water Cooled Chiller



VAV Box



Air Handling Unit



Fan Coil Unit



Roof top Package Unit



Centrifugal Fan



Axial Fan



Boiler



Centrifugal Pump



Water Pipes

7- Different types of I/O List

Analog input (AI) a sensor that monitors physical data, such as temperature, flow, or pressure.

Analog output (AO) a physical action of a proportional device in the controlled equipment - e.g., actuator opens air damper from 20% to 40%, other dampers, valves, inlet guide vanes, etc.

Digital input (DI) a sensor that monitors status. Momentary and maintained switches, ON-OFF equipment status, and digital pulses from flow and electric power meters are discrete inputs.

Digital output (DO) changes or maintains device status. Performs momentary or maintained switching for start/stop of pumps, fans, two-position dampers, and on/off control.

Analogue Input

- **Examples of A.I.**
  - Temperature Sensor
  - Humidity Sensor
  - Pressure Transducer

Analogue Output

- **Examples of A.O.**
  - Electronic Actuators Valves
  - Electronic Actuators Dampers
  - Speed Control

Digital Input

- **Examples of D.I.**
  - Air Flow Switch
  - Door Contact
  - Water Level Switch

Digital Output

- **Examples of D.O.**
  - Start / Stop Fan
  - Start / Stop Chiller
  - Switch On / Off Lights

Control Loop Optimisation

Outside Air Temp 17C



Zone Temp 22C

Chiller Running

Supply Air Temp 14C
Static Pressure 350pa
VSD Running at 95%

VAV Damper 15% Open



Chiller Stopped



Supply Air Temp 18C
Static Pressure 200pa
VSD Running at 75%



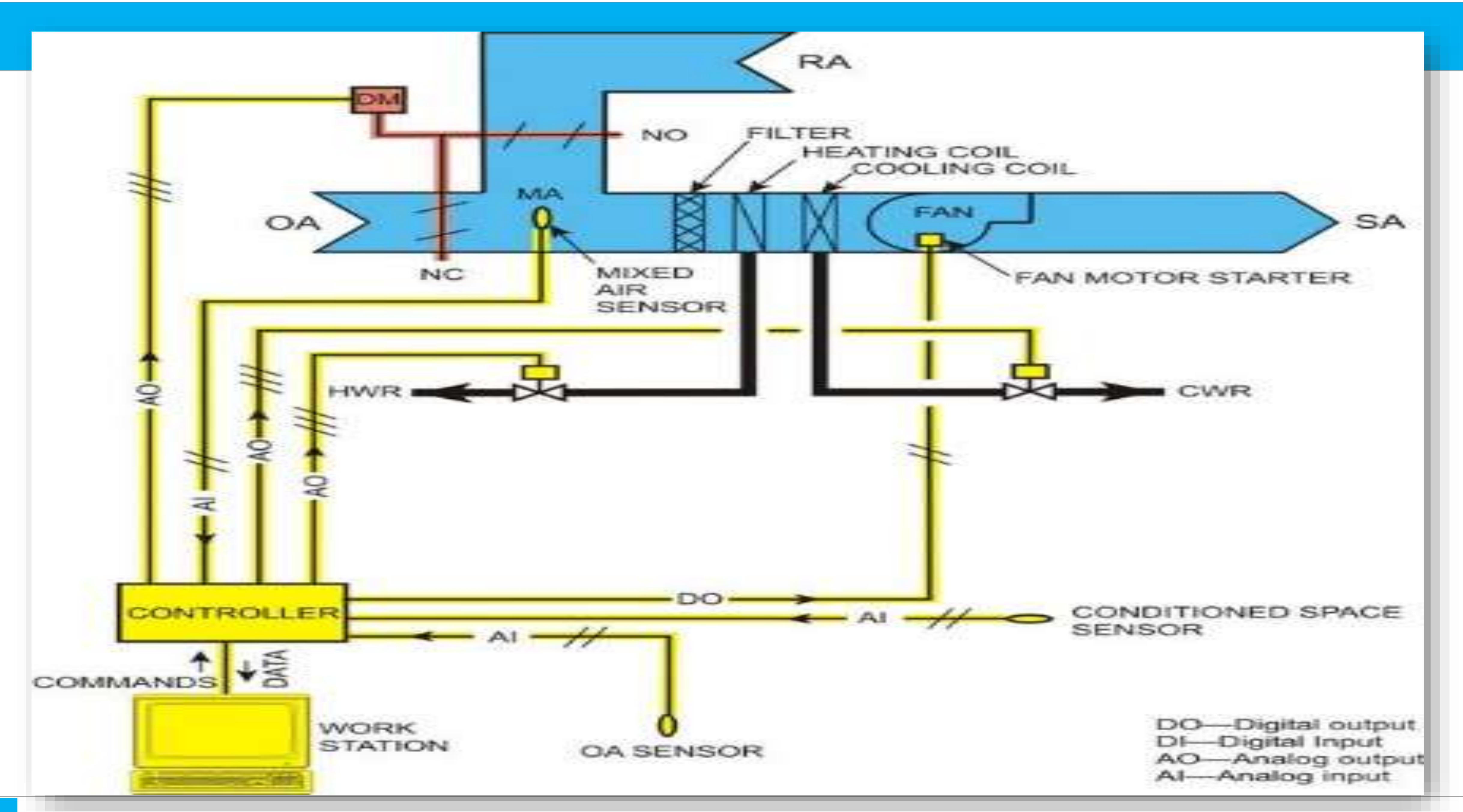
Zone Temp 22C

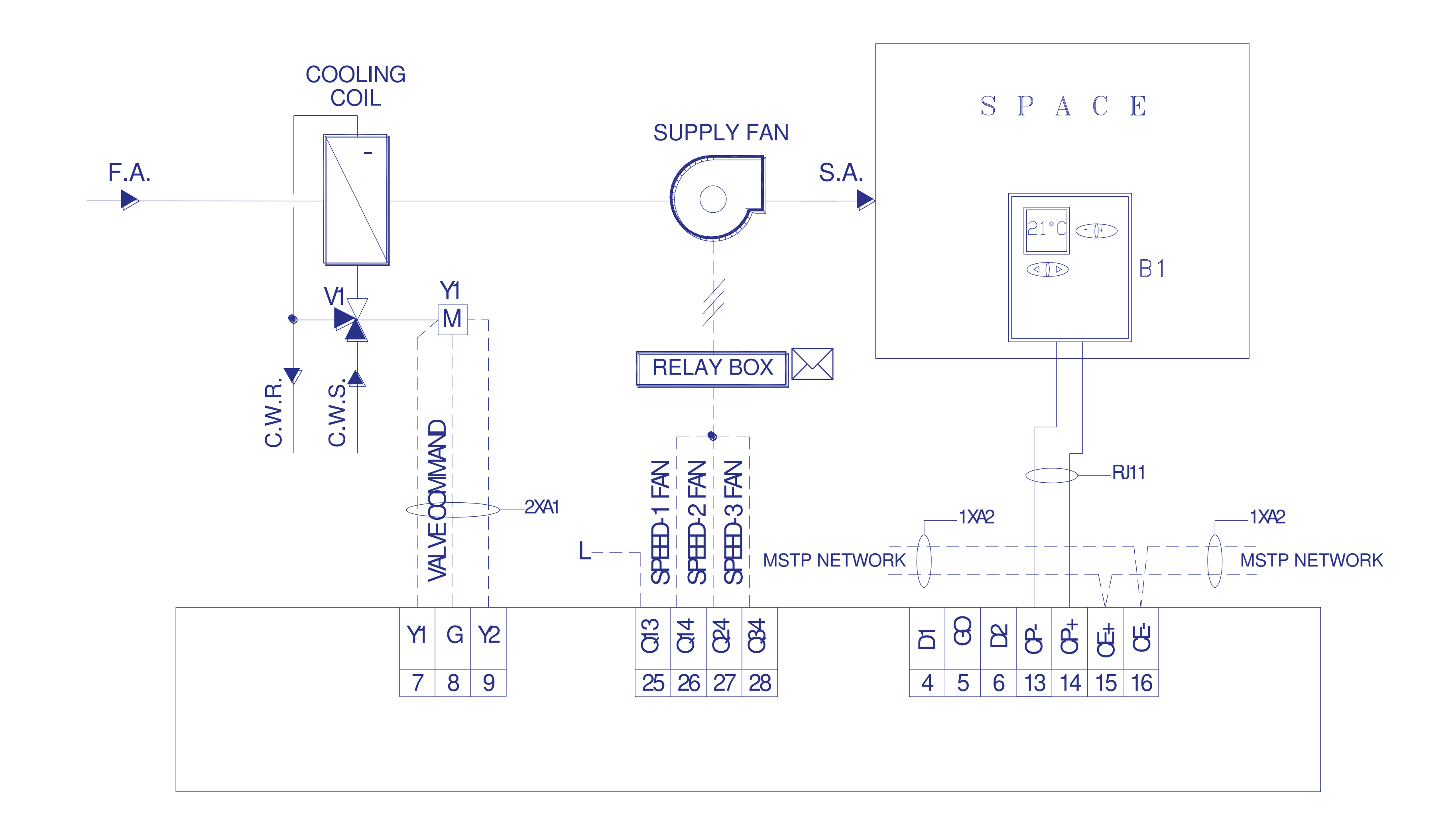
VAV Damper 85% Open

- BMS Drawings show device details and wiring connections

Point Description	DI	DO	AI	AO	HLI	Comments
Chiller HLI					2	Modbus Connection to Chiller
Chiller enable		2				
Chiller run status	2					
Chiller fault status	2					
CHW Pump start / stop		2				At MSSB
CHW Pump run status	2					
CHW Pump speed control				2		Direct to VSDs
CHW Flow temperature			2			
CHW return temperature			1			
CHW system pressure			1			
CHW bypass valve				1		
Tenant Cooling Tower Fans Start / Stop		2				
Tenant Cooling Tower Fans Status	2					
Tenant Cooling Tower Fans Speed				2		
Tenant Cooling Tower Spray Start / Stop		2				
Tenant Cooling Tower Spray Status	2					
Tenant CCW System Pressure			1			
Tenant CCW Pump start / stop		2				
Tenant CCW Pump run status	2					
Tenant CCW Pump speed control				2		
Tenant CCW Flow temperature			1			
Tenant CCW return temperature			1			
Totals	12	10	7	7	2	

- DI – Digital Inputs
- DO – Digital Outputs
- AI – Analogue Input
- AO – Analogue Output
- HLI – High Level Interface


RA
DM
NO
FILTER
HEATING COIL
COOLING COIL
MA
OA
FAN
SA
NC
MIXED AIR SENSOR
FAN MOTOR STARTER
HWR
CWR
AO
AI
AO
AO
CONTROLLER
DO
AI
CONDITIONED SPACE SENSOR
AI
COMMANDS
DATA
WORK STATION
OA SENSOR
DO—Digital output
DI—Digital Input
AO—Analog output
AI—Analog input


COOLING
COIL
F.A.
SUPPLY FAN
S.A.
S P A C E
21°C
B1
V1
Y1
M
RELAY BOX
C.W.R.
C.W.S.
VALVE COMMAND
2XA1
SPEED-1 FAN
SPEED-2 FAN
SPEED-3 FAN
L
RJ11
1XA2
1XA2
MSTP NETWORK
MSTP NETWORK
Y1
G
Y2
7
8
9
Q13
Q14
Q24
Q34
25
26
27
28
D1
GO
D2
CP-
CP+
CE+
CE-
4
5
6
13
14
15
16

F.C.U CONTROL SYS.



POINT DESCRIPTOR	DO	DI	AI	AO	INTERFACE
FCU					
Fan On/ Off Command	3				Interface Relay
Fan Auto Status			1		Volt Free Contact
Fan Trip Status			1		Volt Free Contact
Room Temp Sensor					
Valve Control(3/4")	1				
TOTAL POINTS USED	4	0	2	0	
POINTS AVAILABLE	7	0	8	0	
POINTS SPARE	3	0	6	0	

Open System Protocols – What does this Mean?

- The term "Open System" is often confused with "Open Protocols" but these terms are not interchangeable.

- An "Open Protocol" refers to an industry standard communications dialog that allows BMS controllers to communicate together much like PC's talk on a network in a common language. Two of the major protocols in use are;

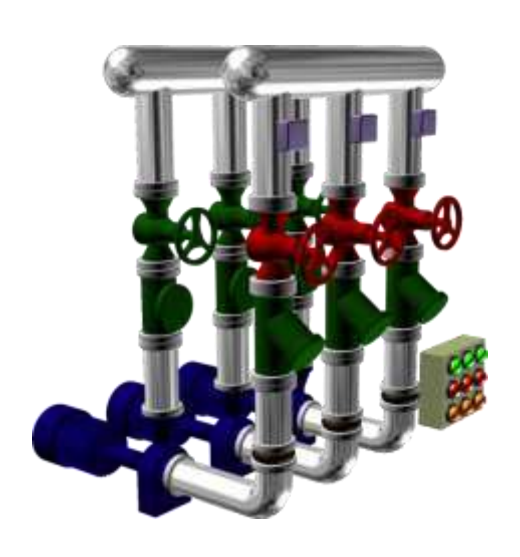




- Do not be confused by which one is the better alternative or which one provides vender independence. ***Vendor specific configuration tools are still required…***

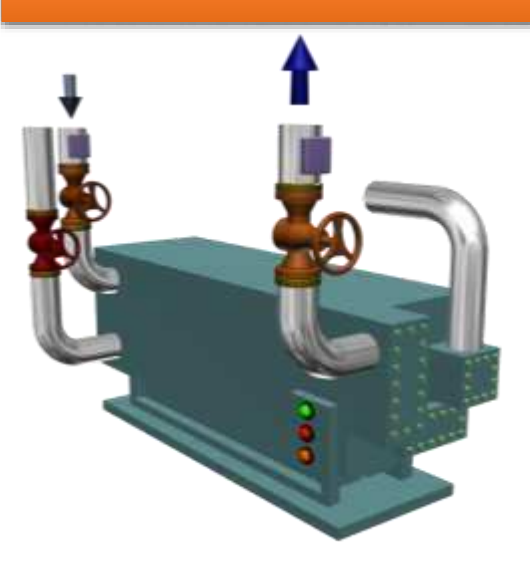
- What you need is an "Open System" and this has less to do with technology and more to do with venders attitude, its staff and their engineering expertise.

PUMP CONTROL SYS.



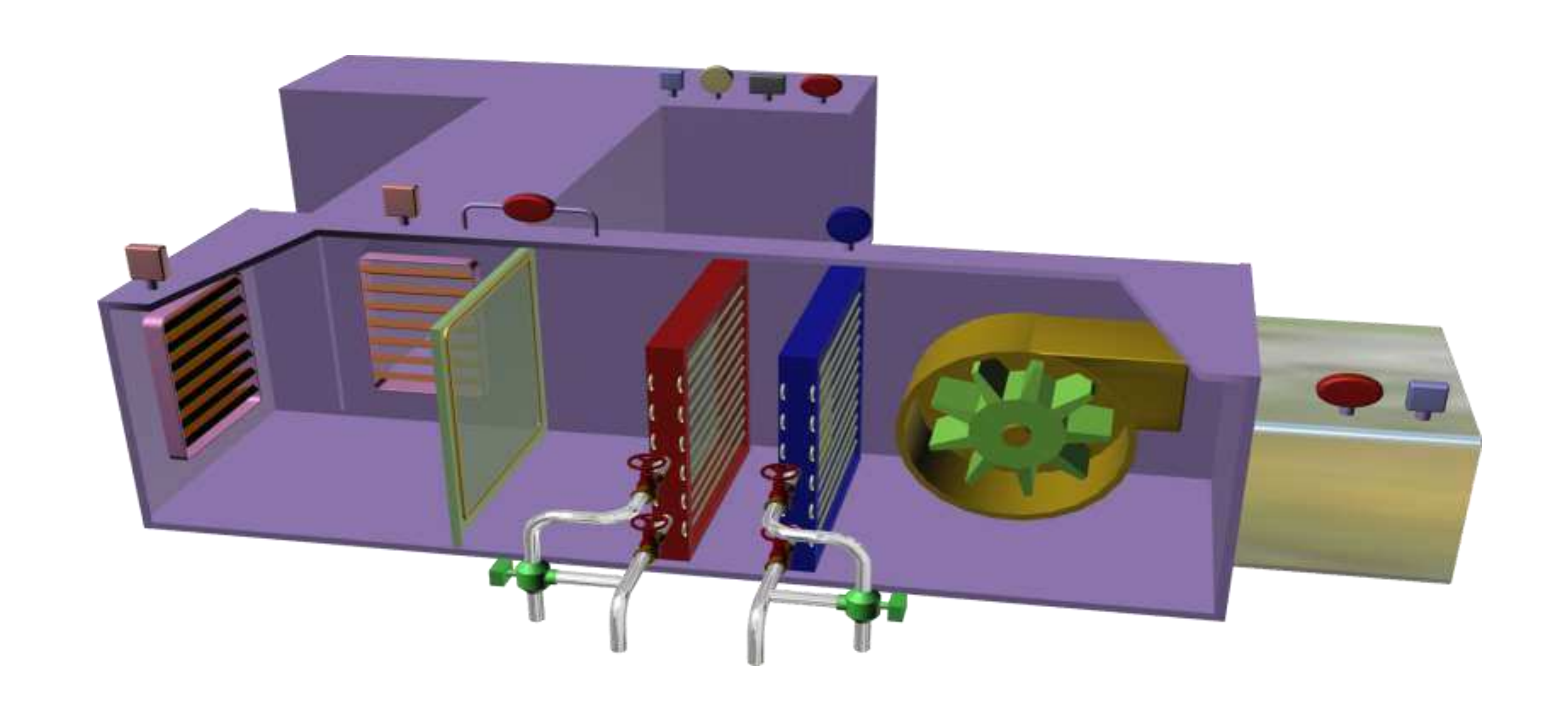
POINT DESCRIPTOR	DO	DI	UI	AO	INTERFACE
Cooling Tower Pump -P-7~11					
Pump Auto Status			5		Volt Free Contact
Pump Start/Stop	5				Interface Relay
Pump Run Status		5			SPU-1201
Pump Trip Status			5		Volt Free Contact
TOTAL POINTS USED	5	5	10	0	
POINTS AVAILABLE	8	8	12	4	
POINTS SPARE	3	3	2	4	

CHILLER CONTROL SYS.



POINT DESCRIPTOR	DO	DI	UI	AO	INTERFACE
CHILLER ABS.-1,2					
Chiller Run Status			2		Volt Free Contact
Chiller Common Fault			2		Volt Free Contact
Chiller Auto/Manual Status		2			Volt Free Contact
Chiller Enable/Disable	2				Interface Relay
Condenser Water Supply Temp			2		STP660
Condenser Water Return Temp			2		STP660
Chilld Water Supply Temp			2		STP660
Chilld Water Return Temp			2		STP660
Chilld Water Flow Switch		2			SFW1251
Water Flow Switch		2			SFW1251
TOTAL POINTS USED	2	6	12	0	
POINTS AVAILABLE	8	8	12	4	
POINTS SPARE	6	2	0	4	

AHU CONTROL SYS.



AHU CONTROL SYS.

POINT DESCRIPTOR	DO	DI	AI	AO	INTERFACE
A.H.U 1					
Fresh Damper Actuator			1	1	LF24-SR
Return Damper Actuator			1	1	LF24-SR
Filter Dirty		1			SPD900-200pa
Ducted Smoke Detector		1			UG-2-A2O
Ducted CO2 Sensor			1		SCD100
Ducted Humidity Sensor			1		SHD100
Air Quality			1		SCR100
VSD Speed Commond / Feedback			1	1	Altivar 21 - Type xx
Supply Air Pressure			1		SPD310
TOTAL POINTS USED	0	2	7	3	
POINTS AVAILABLE	6	2	10	4	
POINTS SPARE	6	0	3	1	

Hekmat

DDC HARD WIRED INPUTS / OUTPUTS

DDC PART NO. & REF. : MN-550, DDC-1

DDC PANEL REF. & LOCATION :

POINT DESCRIPTOR	DO	DI	AI	AO	INTERFACE
A.H.U 1					
Cooling Coil Control (2,1/2")			1	1	731-2053-000
Heating Coil Control (1,1/2")			1	1	731-4145-000
FAHU Auto Status		1			Volt Free Contact
FAHU Start/Stop	1				Interface Relay
Supply Fan Status			1		SPD900-200pa
FAHU Trip Status			1		Volt Free Contact
Return Air Temperature			1		STD660
Supply Air Temperature			1		STD660
Room Temperature Sensor			1		STR600
Anti Frost		1			TCL1602
TOTAL POINTS USED	1	2	7	2	
POINTS AVAILABLE	6	2	10	4	
POINTS SPARE	5	0	3	2	

THANK YOU